Lat 40.31311 Lon -120.79632

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Date: May 16, 1996

Subject: Southside Analysis Input - The use of mean annual precipitation to predict true fir mortality (Report NE96-5)

To: Eagle Lake District Ranger, Lassen National Forest

Introduction

The Southside Analysis area has experienced above normal levels of conifer mortality over the past several years. This mortality has most commonly been observed in white and red fir. In the early 1990's most of the mortality was in the white fir. More recently, over the past 3 years, the mortality has been affecting red fir. Extensive stand exam data has been collected in part of this analysis area. This readily available information combined with the recent protracted drought period and subsequent mortality presented an opportunity to examine the use of mean annual precipitation as a way to rate the risk of true fir mortality. This report summarizes our findings and provides some insight on how information of this type can be taken into consideration when developing and implementing management guidelines and objectives.

Background Information

The Southside Analysis area lies completely within the transition zone, although the eastern part of the area extends nearly to the eastside. The transition zone is characterized by slightly higher annual precipitation and greater topographic variation than the eastside. Parts of the analysis area have been salvaged within the past three years under pre-CASPO guidelines. Wildlife areas which comprise a majority of the area considered in this analysis have had limited entry. Stand exam data was collected during the fall primarily in the Hamilton Mountain/Coyote Peak area of the Southside Analysis. This report will concentrate on that area, however, the entire area will be discussed as appropriate. Over 1,600 acres of the analysis area were sampled with over 400 points/sample plots.

Individual conifer species can grow under a range of precipitation regimes. Land managers should be cognizant of these precipitation regimes when developing land management objectives based on existing vegetation. Objectives may not be attainable if species have established in the wetter or drier extremes of their ranges since these sites will not likely be suitable for the duration of the tree's lives and therefore the species will not be sustainable.

Given the high level of mortality in the analysis area and knowledge of the pattern of mortality over the past few years, our objective was to determine if

the pattern of true fur mortality could have been predicted prior to the onset of the drought using an isohyetal map of mean annual precipitation. If so, it would be expected that levels of conifer mortality would be higher in areas where species are growing at the lower limit of their precipitation needs. During protracted drought periods the mortality would be expected to occur in the lower precipitation areas at the onset of the drought and then extend into the higher precipitation areas if the drought continues.

Based on the isohyetal map of mean annual precipitation the normal precipitation ranges from 20-30 inches a year (See attached maps and overlays) with the higher precipitation being received in the west part of the analysis area (Source: Rantz, S.E. 1969. Mean Annual Precipitation in the California Region. U.S.G.S. Menlo Park, CA). These maps represent broad averages of conditions over large areas. Microsites, which are very different from the broad average, probably exist within the isohyetal bands.

Several conifer species exist throughout the analysis area including Douglas fir, sugar pine, incense cedar, red and white fir and ponderosa pine. Site indices range from 30 to 50. Each species of vegetation has a competitive advantage along the soil moisture gradient. Various weather patterns, in combination with management practices (ie. fire suppression, harvesting practices) can enable different species to occupy various sites for many years or centuries. This is likely the case for several areas in the analysis area. Regardless of the mechanisms that were involved in the development of the current vegetation, the following conclusions can be made about the existing condition:

1) white fir is much more predominant at the lower elevations in the analysis area than likely existed prior to European settlement

2) red and white fir are present in areas which under normal conditions receive precipitation that is near the lower limit for these species

3) existing stocking levels are higher than some sites can maintain through protracted dry periods

These conditions do not lend themselves well to being able to withstand the frequent occurrence of below normal precipitation periods experienced in California. Some trees have developed in areas where even the normal annual precipitation is less than what is needed to sustain the species over its life time. When normal or above normal precipitation is not received species growing in these areas become drought stressed. This stress is exacerbated by overstocked growing conditions. Conifer species which are growing in areas that receive less than their optimal limit of precipitation, are more susceptible to insects, pathogens and weather disturbances. Both red and white fir have increased in size and number over the past century, however, over the past 10 years, precipitation has been extremely limited. The result of this has been unacceptable levels of true fir mortality. Attainment of some of the management objectives for the management areas encompassed within this analysis has been severely impacted.

Currently, two disturbance factors are causing high levels of red and white fir mortality in the analysis area, drought and attacks by the fir engraver beetle. The mortality over the past few years has increased in general from

lower to higher elevations in the analysis area. This trend can be predicted by examining the precipitation regimes and species occupying these sites.

Results and Discussion

White fir

California white fir grows in cold, high elevations and in warm to hot low elevations (Silvics of North America, Vol. 1 Conifers, U.S.D.A. Agricultural Handbook 654). The best stands of white fir develop in areas receiving 40 - 50 inches per year. The lower limit of precipitation for sustaining white fir is 20 inches per year (Silvics of Forest Trees of the United States, U.S.F.S. Agriculture Handbook 271).

The northeast corner (just south of Elysian Valley) is below the 20 inch isohyet (Fig. 1, blue). Although white fir may be found in this area, it is not biologically realistic to manage it as a resource. White fir existing in areas receiving 20 - 25 inches of annual precipitation (Fig. 1, red) are at the lower limit of their range during normal precipitation periods. This area is east of Aspen Flat. When conditions such as protracted drought or overstocking occur white fir in this area become predisposed to attacks by the fir engraver.

During relatively wet periods, similar to those experienced over the past 100 - 200 years the more shade tolerant white fir has established, and in some cases, has lived long enough to achieve co-dominance and dominance in crown position, however, the sustainability of the majority of these trees is not likely. These areas (20-25 in. annual precip.) should be viewed as being at extreme risk to high levels of mortality during protracted drought periods. Management objectives should emphasize pine and other more drought tolerant species in these areas. Some white fir will survive long periods in this area as evidenced by several large trees, however, management objectives should not attempt to maintain this species as a major stand component. If there is a desire to retain the residual large, live, white fir, it may be necessary to thin around these trees to reduce competition for available soil moisture

White fir occupying sites in the yellow area on the map normally receive 25 - 30 inches of precipitation annually. In general this area is between Gillman Basin and Aspen Flat. The area between Gillman Basin and the radio repeater receive 30 inches annually. Typically in these zones white fir may achieve considerable age and size during normal and above normal precipitation periods. However, they are on the lower end of precipitation for white fir growth and sustainability. Elevated levels of top kill and mortality (in excess of 30% of the stand) should be expected during protracted drought periods.

Stand exam data has been collected extensively within the area receiving 30 inches of precipitation annually. White fir as a percent of species composition ranges from about 1% up to 99%, however white fir is the dominant species (in terms of species composition, > 50%) in 60% of the stands. White fir mortality, expressed as a percent of total white fir basal area in the stands ranges from about 1% to 26%. White fir mortality expressed as a percent of the total mortality ranges from 4% to 100%. In over 69% of the stands, white fir mortality comprises 50% or more of all mortality. Figure 2 shows that when averaging information for all stands white fir makes up 74% of the

total mortality. It is clear from this figure that almost all of the mortality has occurred in the red and white fir (96.6% combined). Although this would be expected because both species occur more often, it should be noted that very little mortality has occurred in other species (primarily ponderosa pine and incense cedar), even when they comprise over 50% of the species composition. This would be expected as these species are more drought tolerant and better adapted to these sites.

Based on recollections from District personnel the white fir mortality first began during the early 1990's at the lower elevations and progressed into the higher elevation sites as the drought continued. This trend corresponds with the isohyetal map of mean annual precipitation for the Southside analysis area.

Red fir

Climate for the red fir zone can be classified in general as cool and moist to cold and moist. Total precipitation within the red fir zone ranges from 30-60 inches annually. The annual precipitation on areas with optimum red fir development averages 40 to 50 inches (Silvics of Forest Trees of the United States, U.S.F.S. Agriculture Handbook 271). During periods of protracted drought red fir mortality would be expected to occur first and be highest in areas near the lower limit of annual precipitation. If the drought continues for several years, mortality would also increase in the higher precipitation zones.

Areas receiving less than 30 inches of annual precipitation are below the range of red fir. Within the Southside analysis area there are several areas that receive less than 30 inches. In general these areas are east of Gillman Basin and west of the radio repeater (Fig. 3, blue). Although this species may be found in these areas, it is not biologically realistic to manage it as a resource. Red fir mortality in excess of 30% of the stand should be expected during protracted drought periods. The area between Gillman Basin and the radio repeater are within the 30 inch isohyets (Fig. 3, red). This amount of precipitation is near the lower limit for sustaining red fir and topkill and/or mortality should be expected during protracted drought periods.

Red fir as a percent of species composition ranges from about 1% to 93%. It is the dominant species (in terms of species composition, > 50%) in 20% of the stands. Red fir mortality, expressed as a percent of total red fir basal area in the stands ranges from about 2% to 27%. Red fir mortality expressed as a percent of the total mortality ranges from 15% to 100%. In over 28% of the stands, red fir mortality comprises 50% or more of all recorded mortality. Figure 1 shows that when averaging information for all stands red fir makes up 23% of the total mortality.

Based on recollections from District personnel red fir mortality was not observed in the analysis area until more recently when compared to white fir mortality. This would be expected as it grows at a higher elevation and in areas that would normally receive more precipitation and snow pack. Drought effects would occur first in areas where red fir is growing at or near the lower precipitation requirements for the species and then progress into the higher precipitation bands if the drought continues.

Conclusions

The objective of this evaluation was to determine if an isohyetal map of mean annual precipitation could be used in the future to rate the risk of true fir mortality. If so, this information could better enable land managers to prioritize areas for management activities such as thinning and also provide information in terms of true fir sustainability which could have implications in resource management planning and objectives. Based on this evaluation for the Southside analysis area, it is apparent that precipitation information can successfully be used in these ways. In general, it can be expected that levels of true fir mortality will be higher in areas where species are growing at the lower limit of their precipitation needs. During protracted dry periods the mortality levels will increase in the lower precipitation areas at the onset of the drought and then extend into the higher precipitation areas if the drought continues. Mortality levels will be highest in areas that are near or below the lower limit of annual precipitation for a given tree species and decrease as the annual precipitation approaches optimum levels for growth and sustainability.

As mentioned earlier, a majority of the Southside analysis area is comprised of special wildlife habitat areas. Mortality levels in several stands have decreased the quality of wildlife habitat and increased the potential of losing the habitat to fire. It is apparent from this evaluation that during protracted drought periods mortality in excess of 30% of the red and white fir should be expected. These sites are capable of growing red and white fir, as evidenced by a large component of red and/or white fir as well as several large trees of these species in the stands. However, the current condition is evidence that sustaining a high percent of these species on these sites is not likely during protracted drought periods.

Depending upon management objectives, some silviculture treatments can enhance or help maintain the coniferous component in the analysis area. Silvicultural treatments can make the stand's growing space available to desirable species and/or put individual trees in a competitively advantageous position. Thinning stands to a lower basal area while favoring those species that are best adapted to the sites should decrease the amount of future mortality in the Southside analysis area. Based on wildlife objectives a majority of this thinning would be from below in an effort to retain the larger diameter trees in the overstory. In addition, thinning around large diameter trees will increase the precipitation and nutrients available to them. Thinning stands in the Southside analysis within the next few years will not likely alter the pattern the mortality currently observed as a result of the recent drought. Thinning should result in lower levels of bark and engraver beetle-related mortality in the future.

Salvaging dead trees has no effect on the beetle populations or future bark beetle-related mortality. Salvage logging would remove some of the wood while it still has some commercial value and also reduce the amount of standing and down fuels. Based on the pattern of mortality over the past few years, it is likely that more trees will die until precipitation levels returns to normal for several consecutive years. The removal of trees expected to die in the near future will possibly decrease the number of entries which may be a priority based on the management objectives for the wildlife areas. Forest Pest Management can assist in the development of marking guidelines as

appropriate. Currently, we are monitoring 100 trees within the analysis area that exhibited various signs and symptoms of insect activity during 1995. Information from this monitoring study can be used to assist in the development of marking guidelines.

If you have any questions regarding this evaluation or request additional assistance please contact Sheri Smith or Robin Petersen at 916-257-2151.

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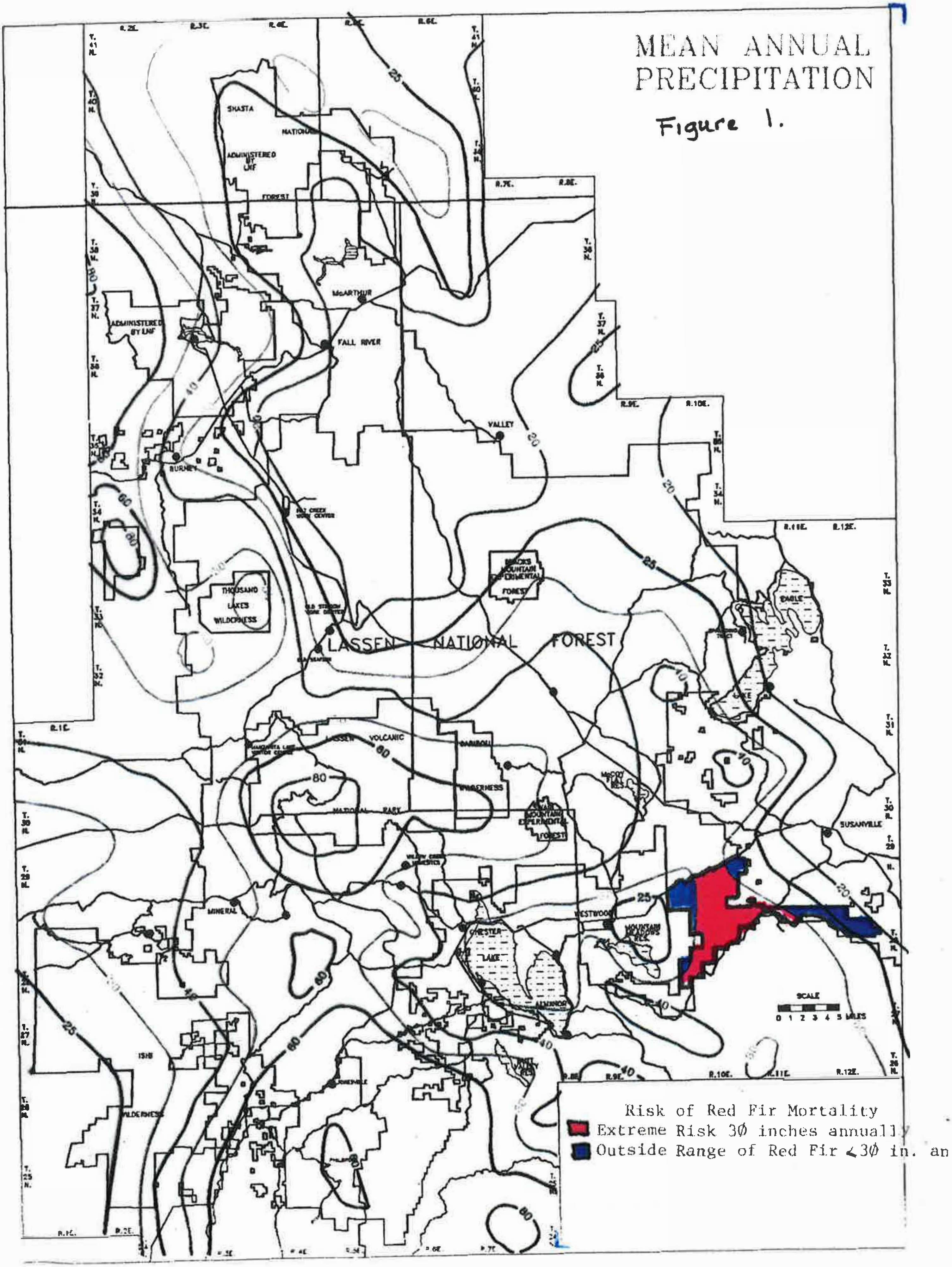
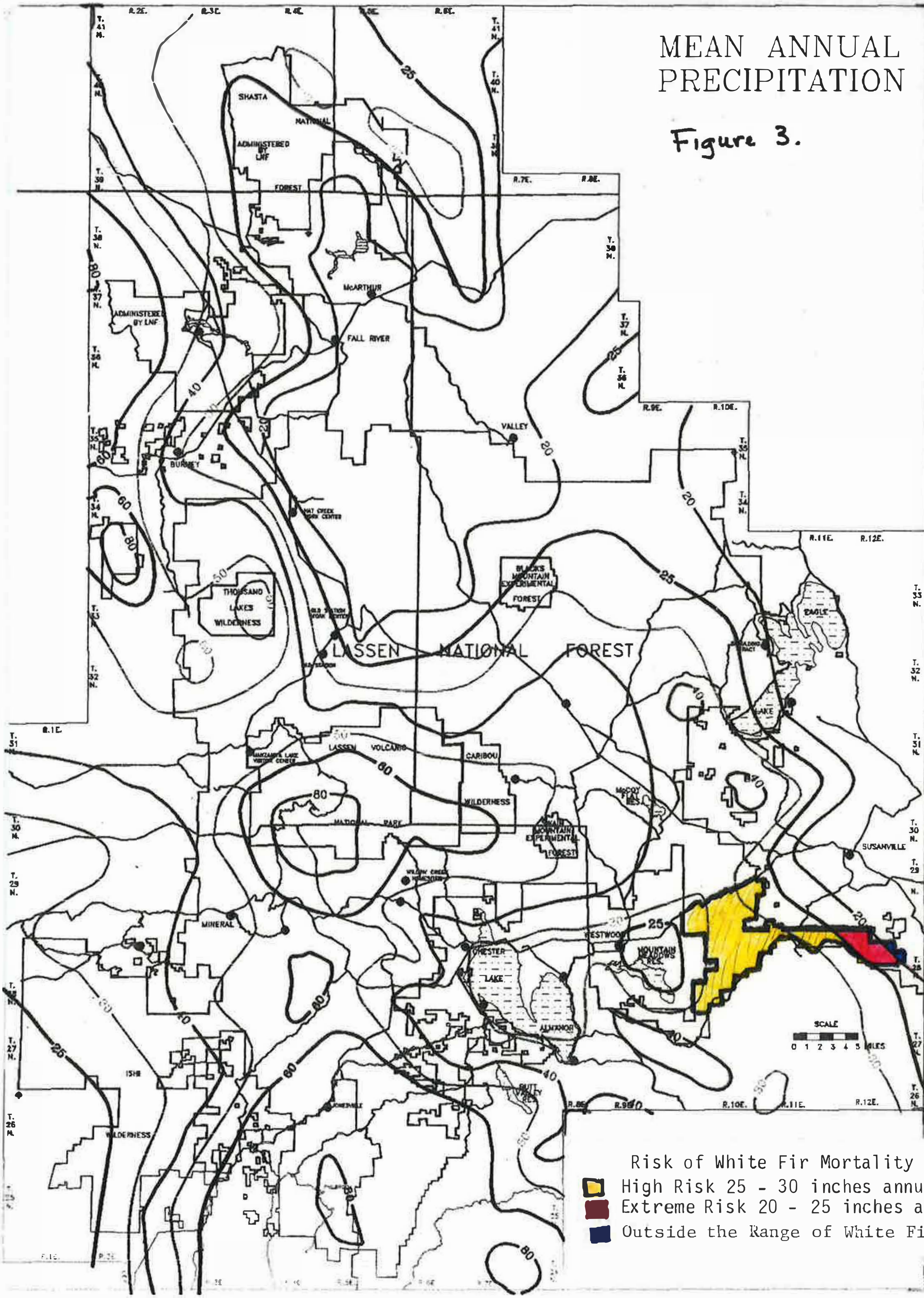

MEAN ANNUAL PRECIPITATION
Figure 1.
Risk of Red Fir Mortality
Extreme Risk 30 inches annually
Outside Range of Red Fir ∠30 in. an
SHASTA
NATIONAL
ADMINISTERED BY LNF
FOREST
McARTHUR
FALL RIVER
ADMINISTERED BY LNF
BURNEY
VALLEY
THOUSAND LAKES WILDERNESS
LASSEN NATIONAL FOREST
LASSEN VOLCANIC NATIONAL PARK
CARIBOU WILDERNESS
SUSANVILLE
EAGLE
LAKE
MINERAL
WESTWOOD
MOUNTAIN MEADOWS RES.
CHESTER
LAKE
ALMANOR
ISHI WILDERNESS
SCALE
0 1 2 3 4 5 MILES

MEAN ANNUAL PRECIPITATION

Figure 3.



Risk of White Fir Mortality

High Risk 25 - 30 inches annually

Extreme Risk 20 - 25 inches annually

Outside the Range of White Fir

Average Percent Mortality By Species